IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appeal Brief (3) Cover 4/5/03

In re Patent Application of

WOLLASTON et al

Atty. Ref.: **540-318**

Serial No. **09/924,490**

Group: **3643**

Filed: **August 9, 2001**

Examiner: **R. Swiatek**

For: **FRICTION WELDING METAL COMPONENTS**

* *

APPEAL BRIEF

On Appeal From Group Art Unit 3643

Stanley C. Spooner
NIXON & VANDERHYE P.C.
8th Floor, 1100 North Glebe Road
Arlington, Virginia 22201-4714
(703) 816-4028
Attorney for Appellant

AF/3643

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
Before the Board of Patent Appeals and Interferences

In re Patent Application of Atty Dkt. 540-318
C# M#
WOLLASTON et al Group Art Unit: 3643
Serial No. 09/924,490 Examiner: Robert Swiatek
Filed: August 9, 2001 Date: April 4, 2003
Title: FRICTION WELDING METAL COMPONENTS

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

☐ **Correspondence Address Indication Form Attached.**

☐ **NOTICE OF APPEAL**
Applicant hereby appeals to the Board of Appeals from the decision dated _____ of the Examiner twice/finally rejecting claims _____ ($) $

☒ An appeal **BRIEF** is attached in triplicate in the pending appeal of the above-identified application ($ 320.00) $ 320.00

☐ Credit for fees paid in prior appeal without decision on merits -$ ( )

☐ A reply brief is attached in triplicate under Rule 193(b) **(no fee)**

☐ Petition is hereby made to extend the current due date so as to cover the filing date of this paper and attachment(s) **($110.00/1 month**; $410.00/2 months; **$930.00/3 months**; $1450.00/4 months) $

SUBTOTAL $ 320.00

☐ Applicant claims "Small entity" status, enter ½ of subtotal and subtract -$( )
☐ "Small entity" statement attached.

SUBTOTAL $ 320.00

Less month extension previously paid on -$(0.00)

TOTAL FEE ENCLOSED $ 320.00

Any future submission requiring an extension of time is hereby stated to include a petition for such time extension. The Commissioner is hereby authorized to charge any deficiency, or credit any overpayment, in the fee(s) filed, or asserted to be filed, or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our **Account No. 14-1140.** A duplicate copy of this sheet is attached.

1100 North Glebe Road, 8th Floor
Arlington, Virginia 22201-4714
Telephone: (703) 816-4000
Facsimile: (703) 816-4100
SCS:kmm

NIXON & VANDERHYE P.C.
By Atty: Stanley C. Spooner, Reg. No. 27,393

Signature: _____

TABLE OF CONTENTS

I. REAL PARTY IN INTEREST

The real party in interest in the above-identified appeal is BAE SYSTEMS plc by virtue of the Assignment (in the parent application serial number 09/212,569 and now U.S. Patent 6,328,261) from the inventors to British Aerospace Public Limited Company recorded January 21, 1999, at Reel 9279, frame 0539, and a name change from British Aerospace Public Limited Company to BAE SYSTEMS plc submitted for recordation on October 12, 2000.

II. RELATED APPEALS AND INTERFERENCES

There are believed to be no related appeals or interferences with respect to the present application and appeal. Applicant notes that two appeals and two separate appeal briefs were noted and filed, respectively, in the grandparent application serial number 09/212,569 which subsequently matured into US Patent 6, 328,261 and also handled by the instant Group Art Unit.

III. STATUS OF CLAIMS

Claims 1, 13, 14, 18, 20, 37-39, 41, 43, 45, 50, 52, 54, 56, 57, 59 and 66 are rejected, with claims 16, 32, 33, 40, 42, 44, 46-49, 51, 53, 55, 58 and 60-65 objected to in the outstanding second non-final Official Action. The Examiner contends that the rejected claims are either anticipated under 35 USC §102 or obvious under 35 USC §103 in view of the cited prior art. The objected to claims

are objected to as being dependent upon rejected claims but otherwise are indicated as containing allowable subject matter.

IV. STATUS OF AMENDMENTS

No further response has been submitted with respect to the second non-final Official Action.

V. SUMMARY OF THE INVENTION

The present invention relates to the friction stir welding of metal, and particular with respect to friction stir welding of metal in the aerospace component field.

Friction stir welding was invented in the early 90's and utilizes a rotating welding pin which is placed into contact with the material to be welded. The rotating pin locally plasticizes the metal in contact with the pin through friction heating and as the pin is moved through the metal, the plasticized material is moved from in front to behind the pin, thereby forming a weld which solidifies as the pin and heat source move away.

Aircraft structural components are inherently complex, especially skin panels, stringers, etc. In order to make such components with minimal parts count, it has previously been known to machine such components out of solid billets of aerospace material such as aluminum, because stiffening stringers can be

machined into a surface panel. The use of a machined stringer, rather than a stringer attached with numerous fasteners, provides greater structural integrity as well, in that there is no stress concentration where each fastener connects the stringer to the panel as would otherwise be the case. The even stress application throughout the stringer/panel interface reduces the possibility of stress concentrations and fatigue crack formation after many cycles of aircraft use.

Similarly, the joining of two components in an abutting relationship, such as fuselage and wing skin components, normally requires a backing plate and rivets between the edges of the components and the doubler backing plates, in order to achieve a flush joint. As with other structural components, the use of rivets establishes stress concentrations requiring thicker and heavier skin than would otherwise be required.

As it is now well known, the assignee, BAE SYSTEMS, is involved in the planning of the A380 aircraft which will be significantly larger than any current aircraft design. Such a corresponding increase in skin panel size would result in the requirement for numerous doublers or backing plates in order to create the needed panel size. As a result, under current aerospace practices, this would considerably increases the weight and complexity of the structure and tends to reduce the strength and simplicity of any resultant aircraft panel or component.

As a result of the need to be able to create aircraft structures in which components are joined evenly and effectively throughout their length without the need to resort to separate fasteners and suffer the complexity and stress concentrations caused thereby, appellants began investigating the possibility of applying friction stir welding techniques to aerospace components.

It is understood that the properties of a joint in aerospace components is particularly significant in that minor cracks, crystalline dislocation, heat stress and other joint weld problems can be the initiation site for fatigue failures which could have tragic results. Accordingly, the application and suitability of friction stir welding techniques to specific structures in the aerospace industry was by no means assured.

Appellants began their testing of various aerospace components and overcame numerous difficulties in applying the friction stir process to the creation of aerospace components. In June of 1997, a British application was filed and in June of 1998, a corresponding PCT application naming the United States was also filed. A continuation (having serial number 09/212,569) of that PCT application matured into U.S. Patent 6,328,261 and the present application is a continuation of that application and was filed on August 9, 2001.

The present specification details the technique of applying friction stir welding to aerospace components in a butt weld relationship in order to provide a

component useful in the aerospace industry. Included in appellants' claims on appeal are details of the structural components which appellants have conclusively proven can be created using friction stir welding techniques in a manner which meets the stringent requirements of the aerospace industry. For example, appellants have reduced to practice the method of applying friction stir butt welding to join structural airframe components (independent claim 1) and structural airframe components which have been created by friction stir butt welding (independent claims 13 and 37) and a wide variety of varying limitations on these features as set out in the dependent claims.

Accordingly, the present invention is characterized by "**at least two components in abutting relationship**" and the "**joining them together by friction stir butt welding.**" The establishment that friction stir butt welding of metals meets the difficult and exacting criteria imposed upon material joining techniques by the aerospace industry and specifically discloses a number of different such butt welds and components made therefrom.

VI. ISSUES

Whether claims 1, 13, 18, 38 and 52 are anticipated by "Friction Stir Process Welds Aluminum Alloys" ("Dawes").

Whether claims 1, 13, 14, 18, 20, 37-39, 41, 43, 45, 50, 52, 54, 56, 57, 59 and 66 are obvious in view of Ellzey in view of Thomas et al.

VII. GROUPING OF CLAIMS

The rejected claims do not stand or fall together and are specifically discussed as distinguishing over the prior art in the argument portion of this Appeal Brief.

VIII. ARGUMENT

1. Discussion of the References

"Friction Stir Process Welds Aluminum Alloys" is an article appearing in the *Welding Journal* apparently in March of 1996, written by Dawes and Thomas ("Dawes"). This early article disclose the principle of friction stir welding as discussed above in the Summary of the Invention. Possible joint configurations are shown in Figure 7 and Dawes certainly suggests that attempts to utilize the friction stir welding technique in the aerospace industry would be appropriate.

Specifically, Dawes suggests that the authors, employed by TWI at Cambridge in the U.K., will "continue research into different aluminum alloys, study different joint configurations and establish weld properties data to help enable acceptance of friction stir welding by the classification societies such as for ship building and aerospace applications." This confirms that the friction stir welding technique did not have proven utility and had not yet been adopted by aerospace organizations. Based upon the article, there was no determination that

friction stir welding was an acceptable manner of joining components in the aerospace community, although there was a suggestion that it could be.

Furthermore, the caption for Table 2 in Dawes specifically lists "industries in which friction stir welding **could** have a major application" identifying the aerospace industry (emphasis added). Again, the use of the word "could" suggests that the technique had not yet been reduced to practice in the Aerospace field.

In the conclusory "Overview" of the article, it is acknowledged that "several industrial companies are conducting pilot studies using friction stir welding in production." Again, if the technique had any utility in the aerospace field, "pilot" studies would not be necessary.

Beside the point not arguing this

No other way to carry out FSW other than by recited process

Thus, the Dawes reference clearly discloses to the public the possibility that friction stir welding could be used and the suggestion that it could be useful in aerospace applications and in the aerospace industry. However, there is no teaching that any actual utility of friction stir welding has been achieved in the aerospace industry. Dawes merely contains a suggestion and an admission that further development and testing of the friction stir welding technique is needed in order to determine its utility in at least the aerospace field.

Ellzey (U.S. Patent 3,023,860) is a patent disclosing aircraft body construction by forming fuselage skin from "continuous lengths or strips or sheet material." (Col. 1, lines 52-54). Ellzey teaches that the strips of material are

overlapped with "the inwardly bent edge portion 10" shown in Figures 7 and 8. Thus in joining adjacent strips of material, Ellzey specifically teaches away from a butt joint and instead requires overlap of the sheets. The Examiner admits that Ellzey teaces conventional welding "to join two overlapped components A', B' together along a curved line." Moreover, there is no disclosure of friction stir welding alleged to be contained in the Ellzey reference and it is noted that such welding was not known in 1957 when the Ellzey patent application was filed.

Thomas (U.S. Patent 5,460,317) is the patent covering friction stir welding and two of the co-inventors, W.M. Thomas and C.J. Dawes, are the co-authors of the Dawes article discussed above. It can also be appreciated that the Thomas patent issued in 1995 and was based upon an application filed in 1992. Consequently, it predates the Dawes article discussed above. Thus, the suggestions in the Dawes article, i.e. that "continued research is necessary in order to help enable acceptance of friction stir welding by the classification societies, such as for ship building and aerospace applications" or that "friction stir welding could have a major application" in the aerospace industry or that "pilot studies for using friction stir welding in production" is the most recent prior art pronouncement on the suitability of the technique for use in the aerospace field.

While the Thomas patent does disclose a number of different manners of implementing friction stir welding using both rotating and cyclically vibrating

bobbins, there is no specific disclosure that the process has utility in the aerospace engineering field.

2. Discussion of the Rejections

Claims 1, 13, 18, 38 and 52 stand rejected under 35 USC §102 as anticipated by Dawes. To the extent the rejection is understood, the Examiner believes that every structure and every structural interrelationship recited in the claims is disclosed in the Dawes reference.

Claims 1, 13, 14, 18, 20, 37-39, 41, 43, 45, 50, 52, 54, 56, 57, 59 and 66 stand rejected under 35 USC §103 as unpatentable over the Ellzey and Thomas references. Again, to the extent it is understood, the Examiner appears to make a number of admissions with respect to this rejection. Specifically, the Examiner admits that Ellzey teaches conventional welding "to join two overlapped components."

The Examiner's contention appears to be that it would be obvious "to eliminate the overlapped, welded portions of the airframe components A', B' of Ellzey and instead join them together by the friction stir butt welding technique disclosed in Thomas." The Examiner's statement that Ellzey recognized the "need for flexibility and opening the door to new and superior welding processes" appears to be an erroneous conclusion that because a prior art patent may broadly

Simply a statement that Ellzey is not wedded to one technique but is open to ~~any teach~~ ~~that~~ ~~or~~ the technique that provides the best results.

encompass a future development, it somehow anticipates or renders obvious such new developments.

3. The Errors in the Final Rejection

There are at least two significant errors in the Final Rejection and they are summarized as follows:

(a) Neither Dawes nor Thomas teach the application of friction stir welding to the butt welding of structural airframe components; and

(b) Ellzey contains no motivation to combine and specifically teaches away from the claimed invention.

(a) Neither Dawes nor Thomas teach the application of friction stir welding to structural airframe components

The Court of Appeals for the Federal Circuit has noted in the case of *Lindemann Maschinenfabrik GMBH v. American Hoist & Derrick*, 221 USPQ 481, 485 (Fed. Cir. 1984) that "[a]nticipation requires the presence in a single prior art reference disclosure of each and every element of the claimed invention, arranged as in the claim."

In the application of the Dawes reference under §102 and the Thomas reference under §103, the Examiner appears to be suggesting that it would be **obvious to try** friction stir welding for structural airframe components for an aircraft as set out in each of the claims on appeal. However, "whether a particular

combination might be 'obvious to try' is not a legitimate test of patentability." *In re Fine*, 5 USPQ2d 1596, 1599 (Fed. Cir. 1988) *(additional citations omitted)*.

Because the Dawes co-authors included two of the Thomas patent inventors and was published after the issuance of the Thomas patent, it is believed to be the authority of what was known at the time of publication. Therefore, the following discussion will address the Dawes article but equally applies to the Thomas patent.

The Examiner refers to page 45 of Dawes as allegedly teaching structural airframe components having the claimed friction stir butt welded joint. However, as noted above, Dawes merely includes a discussion of Figure 7 under the heading of "Future Development" and contains no suggestion that these possible configurations are actual friction stir welding examples.

In fact, Dawes specifically states that the originators of the friction stir welding (including the authors of Dawes) will "continue research into different aluminum alloys, study different joint configurations and establish weld properties data to help enable acceptance of friction stir welding by the classification societies, such as for ship building and aerospace applications." (Dawes, page 45, first column). This statement is an clear indication that, at least as of the March 1996 publication date of the Dawes article, additional research was necessary into using frictional stir butt welding for "different aluminum alloys" or

"different joint configurations" or "weld properties data" so that the concept could be accepted for "aerospace applications."

Table 2 of the Dawes article, apparently pointed to by the Examiner as teaching use in the aerospace field, merely discloses "industries in which friction stir welding **could** have a major application" *(emphasis added)*. While this suggests that friction stir welding might have an application in the aerospace field, particularly with reference to "airframes, fuel tanks and attachment of special alloy skins," there is no teaching or suggestion that friction stir welding actually does have utility in the aerospace application.

Dawes at Figure 7 shows a number of different "configurations suited to friction stir welding." While these configurations may be "suited" to friction stir welding, there is no indication in Figure 7 that the configurations are examples of friction stir welding or that such welding has any utility. As Dawes states, "the joint configurations illustrated offer further design opportunities for numerous industrial applications and consequently will be investigated." In other words, Figure 7 is a disclosure of various existing welds which might be useful if the friction stir welding technique is applied to those configurations. Because such "joint configurations. . . will be investigated" Dawes does not contain a teaching of any present utility for the alleged disclosed configurations.

Finally, Dawes admits that the ship building and aerospace applications are not yet accepted by "the classification societies," presumably a reference to aerospace professionals who provide some level of approval for aerospace fabrication techniques and that such has not yet been indicated as acceptable. In the conclusory "Overview," the Dawes article states that "several industrial companies are conducting pilot studies for using friction stir welding in production." Again, the fact that friction stir welding is being studied does not indicate that the technique has utility in the structural airframe component field.

Thus, it is clear that the Dawes article does not contain any teaching of friction stir butt welding or any teaching that such welding could have utility in creating appellants' claimed structural airframe components.

The best that can be said about the Dawes article and the Thomas patent is that they suggest the possibility that friction stir welding might have some usefulness if applied to the structural airframe component field. However, the test under §102 is whether the cited reference contains a disclosure of the claimed invention, which is clearly missing in both Dawes and Thomas. In view of the above discussion, Dawes clearly fails to disclose any structural airframe component, let alone the specific butt welding of such componenets disclosed in the claims on appeal.

Under the provisions of 35 USC §103, the Thomas reference, in combination with Ellzey, must suggest that the application of friction stir welding to structural airframe components has some utility or that it would be obvious to those of ordinary skill in the art that it has some utility. The indication that it has not been accepted by the "classification societies," the indication that it "could have a major application" and the indication that the disclosed joint configurations "will be investigated" and that several industrial companies are "conducting pilot studies" all indicate to those having ordinary skill in the art that at the time Dawes was published in March 1996, the technique did not have any known utility, at least with respect to structural airframe components, although such utility was suggested as a possibility for further investigation as of the issuance of the Thomas patent.

No, just that FSW has utility in produc. strong joints

As a result, neither Dawes nor Thomas disclose any utility for friction stir welding in the structural airframe component field and, therefore, neither of these references support a rejection under §102 or §103.

(b) Ellzey contains no motivation to combine and specifically teaches away from the claimed invention.

(1) No motivation to combine references

Claims 1, 13, 14, 18, 20, 37-39, 41, 43, 45, 50, 52, 54, 56, 57, 59 and 66 stand rejected under 35 USC §103 as unpatentable over the Ellzey and Thomas

references. Appellant hereby incorporates the above comments with respect to the Thomas, and subsequent Dawes references and identifies such teachings as Dawes in these further discussions.

Appellants' independent claims 1, 13 and 37 all recite a " structural airframe component" which is created by "at least one friction stir butt welded joint." The Examiner will admit that Ellzey contains no teaching or suggestion of benefit of friction stir butt welding. Dawes, as noted above, fails to teach any utility for a "friction stir butt welded joint" applied to a "structural airframe component" (and in fact the Examiner's prior art suggests that there was no utility established as of March 1996). As a result, there is no suggestion for combining the Thomas (Dawes) and Ellzey prior art.

With respect to the combination of references, the Court of Appeals for the Federal Circuit has held that "teachings of references can be combined *only* if there is some suggestion or incentive to do so." *In re Fine*, 5 USPQ2d 1596, 1599 (Fed. Cir. 1988). With respect to the required motivation for combining these references, in the recent case of *In re Rouffet* , 47 USPQ2d 1453, 1458 (Fed. Cir. 1998), the Court held that:

> "the examiner must show reasons that the skilled artisan, confronted with the same problems as the inventor and with no knowledge of the claimed invention, would select the elements from the cited prior art references for combination in the manner claimed."

Nowhere in either of the cited references does there appear to be any recognition of the problems solved by the claimed invention, just the possibility of aerospace applications.

Firstly, Table 2 of Dawes (and, to a lesser extent, its predecessor Thomas) suggests that friction stir welding "could" or "might" have a major application in the aerospace engineering field. This is a clear teaching that, at the time of the article, there was no known utility for the friction stir welding technique in the aerospace field.

Secondly, also as noted above, Figure 7 in Dawes shows possible welding configurations to which friction stir welding techniques might be applied and Dawes specifically states that these "[t]he joint configurations illustrated offer further design opportunities . . . and consequently will be investigated." a further indication of potential, but unconfirmed utility.

The Examiner's conclusion that "Dawes clearly teaches the usefulness of the friction stir butt welding process in the aircraft industry" is respectfully traversed as it has already been established that, in at least four instances, Dawes suggests that, while friction stir welding might be advantageous in the aerospace industry, the usefulness has not been shown and in fact, Dawes appears to admit that it has not yet been adopted by "classification societies" for aerospace applications. Dawes clearly **does disclose** friction stir butt welding. Dawes also

suggests that this might be useful in aerospace applications at some point in the future. Dawes clearly **does teach** that a number of possible joint configurations "will be investigated." Dawes **does disclose** that companies are conducting "pilot studies" for using friction stir welding.

However, Dawes **does not disclose** that metal pieces are "clearly capable" of being joined by friction stir butt welding. Moreover, even if Dawes suggested that metal pieces were "capable" of being joined, this is not a disclosure of the method or apparatus recited, i.e. "structural airframe components" made by the butt welding friction-stir process.

Absent a proper disclosure of a motivation for combining the references, the PTO has failed to meet its burden of establishing a prima facie case of obviousness and the rejection under 35 USC §103 fails.

(2) Ellzey teaches away from a butt joint and friction stir welding

In the *Fine* case, the Federal Circuit also opined that it is "error to find obviousness where references 'diverge from and teach away from the invention at hand'." *Id.* The Ellzey patent, as admitted by the Examiner, teaches the requirement of (a) overlapping the edges of (b) the same piece of material and (c) using non-friction stir welding.

Ellzey requires overlapping edges (10) as shown in Figures 7 & 8 and as discussed at column 4, lines 14-20. This teaching of a need to overlap the edges

that are to be joined alone would lead one of ordinary skill away from a butt joint and towards an overlapping joint.

Ellzey also teaches that the same piece of material is welded to itself and therefore teaches away from welding "at least two components" together. The teachin is that the sheet being welded is a single continuous sheet of material which is helically wound with the edge of one winding being welded to the edge of the adjacent winding. Thus Ellzey teaches away from "at least two components."

Still, 2 components are welded together

Finally, Ellzey teaches conventional welding (and friction stir welding did not exist at that time). The Examiner appears to suggest that because Ellzey suggests that its teaching is not limited by the specific welding technique taught, it envisions friction stir butt welding. There is no precedent for the Examiner's novel theory, which taken to its logical conclusion would have rendered obvious the transistor radio since vacuum tube radios envision all possible amplifiers.

I have not stated this

Given any one of the three above examples, the Examiner should hold that Ellzey teaches away from the present invention. However, given all three reasons, it is indisputable that Ellzey does not aid the PTO in its obviousness argument.

While the above deals with the rejections of independent claims 1, 13 and 37, the dependent claims over additional limitations also missing from the cited prior art.

Claim 14 limits claim 13 to the a component which in the vicinity of the butt-welded joint has a double curvature. Claim 18 limits the "at least one" component of claim 13 to "two skin panels" which are butt welded together. Claim 20, limits claim 13 to "two extruded integrally-stiffened wing panel sections." Claim 38 is to an airframe with at least one component friction stir butt welded as in claim 13. Claim 39 is to an aircraft wing with at least one component friction stir butt welded as in claim 13. Claims 41 and 43 limit claim 14 (double curvature) to skin panels or wing panel sections , respectively, which are butt welded together. Claim 45 limits the components in dependent claim 18 to integrally-stiffened wing panel sections. Claims 50, 52, 54, 56-59 and 66 are all airframe claims which are limited by the components in claims 14, 18, 41, 20, 43, 45 and 37, respectively.

Because the Examiner fails to point out where any prior art reference shows or suggests the features of these dependent claims, he fails to support his blanket obviousness rejection and the same is respectfully traversed.

IX. CONCLUSION

As noted above, Dawes, and its predecessor Thomas, do not disclose friction stir butt welding for airframe structural components although they suggest that such could be a possible application. The Examiner, in omitting any motivation for combining references, has failed to establish a prima facie case of

obviousness. Ellzey, in teaching conventional welding to join overlapped edges of a single component clearly teaches away from the use of friction-stir butt welding to join two components together.

Thus, and in view of the above, the rejections of claims 1, 13, 14, 18, 20, 37-39, 41, 43, 45, 50, 52, 54, 56, 57, 59 and 66 over the cited prior art are clearly in error and reversal thereof by this Honorable Board is respectfully requested.

Respectfully submitted,

NIXON & VANDERHYE P.C.

By: _____

Stanley C. Spooner
Reg. No. 27,393

SCS:kmm
Enclosures
Appendix A - Claims on Appeal

APPENDIX A

Claims on Appeal

1. A method of forming a structural airframe component for an aircraft including placing at least two components in abutting relationship with each other and joining them together by friction stir butt welding.

13. A structural airframe component for an aircraft including at least one friction stir butt welded joint.

14. A structural airframe component as in claim 13 wherein, in the region of a said butt welded joint the component is double curvature in form.

18. A structural airframe component as in claim 13 in which the component comprises at least two skin panels friction stir butt welded together.

20. A structural airframe component as in claim 13 in which the at least one friction stir butt welded joint joins at least two extruded integrally-stiffened wing panel sections.

37. A structural airframe component for an aircraft manufactured by placing at least two components in abutting relationship with each other and joining them together by friction stir butt welding.

38. An airframe for an aircraft including at least one structural airframe component according to claim 13.

39. An aircraft wing including at least one structural airframe component according to claim 13.

41. A structural airframe component as in claim 14 in which the component comprises at least two skin panels friction stir butt welded together.

43. A structural airframe component as in claim 14 in which the at least one friction stir butt welded joint joins at least two extruded integrally-stiffened wing panel sections.

45. A structural airframe component as in claim 18 in which the at least one friction stir butt welded joint joins at least two extruded integrally-stiffened wing panel sections.

50. An airframe for an aircraft including at least one structural airframe component according to claim 14.

52. An airframe for an aircraft including at least one structural airframe component according to claim 18.

54. An airframe for an aircraft including at least one structural airframe component according to claim 41.

56. An airframe for an aircraft including at least one structural airframe component according to claim 20.

57. An airframe for an aircraft including at least one structural airframe component according to claim 43.

59. An airframe for an aircraft including at least one structural airframe component according to claim 45.

66. An airframe for an aircraft including at least one structural airframe component according to claim 37.